§6 結　　論

我々の行つた方法は摘要で並べた様に忠実度が良く短時間に試料を作成出来る一段レプリカ法であるが，§2 の蒸着 Al 電解酸化一段レプリカ法は非常に良い結果が得られる。§3 の蒸着 SiO_2 一段レプリカ法は皮膜の剝離方法を更に考究する必要がある。§4 の蒸着 Ni 酸化皮膜法は酸化の程度が重要な因子に入るため技巧を必要とする。§5 の剝離層を置く蒸着一段レプリカ法は容易に試料は作成されるが，忠実度の点で §2 の蒸着 Al 電解酸化一段レプリカ法に劣る様に思はれる。

我々の方法は蒸着物質を適当に選び，剝離を適当にすれば忠実度が良く，且短時間に試料が作成される一段レプリカ法として多種多様な試料に適用され得るものと思はれる。

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On the Functions with Bounded Real or Imaginary Parts.

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Abstract.

In this paper we consider the class $\mathfrak{S}$ of the functions of the form

$$\text{(A)} \qquad F(z)=\sum_{\nu=1}^{\infty} a_\nu z^\nu \quad (a_1=1)$$

regular and univalent in the unite circle such that

$$\text{(B)} \qquad |R[F(z)]|<M \quad \text{or} \quad |I[F(z)]|<M.^{1)}$$

In § 1 and 2 we will treat with the coefficient problem and some inequalities which hold true for $R[F(z)]$, $I[F(z)]$ and for $|F(z)|$ of the class $\mathfrak{S}$. In §3 and 4, applying the transformation used in §1 and 2, we will add some properties of the mapped region of $|z|<1$ by the function of the class $\mathfrak{S}$, and in the last section we will find the radius of univalency for the functions which are regular in $|z|<1$ and have the properties (A) and (B).

§ 1.

Let

$$(1.1) \qquad F(z)=\sum_{\nu=1}^{\infty} a_\nu z^\nu \quad (a_1=1)$$

be a function regular and univalent in $|z|<1$. If $F(z)$ is bounded in $|z|<1$, *i, e,*

$$|F(z)|<M \quad (|z|<1),^{2)}$$

then we have, by G. Pick,

$$|a_2| \leqq 2\left(1-\frac{1}{M}\right).$$

In this section we will find the analogous property for a_2, when $F(z)$ belongs to the class $\mathfrak{S}$.

If (1.1) is a regular function in $|z|<1$ which has the property (B), we have already known that

$$(1.2) \qquad M \geqq \frac{\pi}{4}.$$ [3]

Therefore the same inequality is also true for the functions of the class $\mathfrak{S}$, and the equality $M=\frac{\pi}{4}$ holds for the functions

$$F(z)=\frac{1}{2}\log\frac{1+z}{1-z} \quad \text{and} \quad F(z)=\frac{1}{2i}\log\frac{1+iz}{1-iz}$$

which belong to the class $\mathfrak{S}$, where the logarithm is taken such that the value is 0 for $z=0$.[4] Hence, for the functions of the class $\mathfrak{S}$,

$$M \geqq \frac{\pi}{4}$$

and $\pi/4$ cannot be replaced by any greater number.

Now we consider the function

$$(1.3) \qquad \varphi(z)=N\frac{\exp\frac{2}{N}F(z)-1}{\exp\frac{2}{N}F(z)+1}, \quad \left(N=\frac{4M}{\pi}\geqq 1\right)$$

where $F(z)$ belongs to the class $\mathfrak{S}$ and $|I[F(z)]|<M$. Then $\varphi(z)$ is regular and univalent in $|z|<1$, and by $W=\varphi(z)$ the unite circle in z-plane is transformed into a region in W-plane which lies entirely in the circle $|w|<N$.

And more, by simple calculations,

$$\varphi(z)=z+a_2z^2+\left(a_3-\frac{1}{3N^2}\right)z^3+\ldots\ldots\ldots\ldots$$

Hence, by the theorem due to G. Pick, we have

$$|a_2| \leqq 2\left(1-\frac{1}{N}\right)$$

If $F(z)$ is of the type (A) and $|R[F(z)]|<M$, we can prove this inequality by the similar way, using

$$(1.4) \qquad \varphi(z)=\frac{N}{i}\frac{\exp\frac{2i}{N}F(z)-1}{\exp\frac{2i}{N}F(z)+1}$$

in replace of (1.3).

That the number $2\left(1-\frac{1}{N}\right)$ in the above result is the best possible one is shown as follows.

The particular function $\varphi_1(z)$, defined by

$$(1.5) \qquad \frac{\varphi_1(z)}{\left[1-\frac{\varepsilon}{N}\varphi_1(z)\right]^2}=\frac{z}{(1-\varepsilon z)^2}, \quad (|\varepsilon|=1)$$

is regular bounded $(|\varphi_1(z)|<N)$ and univalent in $|z|<1$ and

$$\varphi_1(z)=z+2\varepsilon\left(1-\frac{1}{N}\right)z^2+\ldots\ldots\ldots\ldots$$

So that, for the functions

$$(1.6) \qquad F(z)=\frac{N}{2}\log\frac{N+\varphi_1(z)}{N-\varphi_1(z)}=z+\sum_{\nu=2}^{\infty}a_\nu z^\nu, \quad (|I[F(z)]|<M)$$

and

$$(1.7)\qquad F(z)=\frac{N}{2i}\log\frac{N+i\varphi_1(z)}{N-i\varphi_1(z)}=z+\sum_{\nu=2}^{\infty}b_\nu z^\nu,\ (\,|\,R[F(z)]\,|<M)$$

which belong to the class $\mathfrak{S}$, we have

$$|a_2|=2(1-\frac{1}{N}),\quad |b_2|=2(1-\frac{1}{N}).$$

Thus we have the conclusion stated as follows.

Theorem 1.

Let $F(z)=\sum_{\nu=1}^{\infty}a_\nu z^\nu$ $(a_1=1)$ *be any function of the class* $\mathfrak{S}$, *then*

$$|a_2|\leqq 2\,(1-\frac{1}{N}),\qquad N=\frac{4M}{\pi}.$$

And in this inequality $2\,(1-\frac{1}{N})$ *cannot be replaced by any smaller number.*

§ 2.

Let $F(z)$ be a function of the class $\mathfrak{S}$ and $|\,I[F(z)]\,|<M$, then the function $\varphi(z)$, defined by (1.3), is regular and univalent in $|z|<1$ and morever

$$|\varphi(z)|<N,\qquad \varphi(0)=0,\qquad \varphi'(0)=1.$$

Therefore we obtain, by the theorem due to G. Pick for bounded functions,[5)]

$$(2.1)\qquad Nr\leqq\left|N\frac{\exp\frac{2}{N}F(z)-1}{\exp\frac{2}{N}F(z)+1}\right|\leqq NR,$$

where

$$(2.2)\qquad \begin{aligned} r&=\frac{1+|z|-\sqrt{(1+|z|)^2-4N^{-1}|z|}}{1+|z|+\sqrt{(1+|z|)^2-4N^{-1}|z|}}\\ R&=\frac{\sqrt{(1-|z|)^2+4N^{-1}|z|}-(1-|z|)}{\sqrt{(1-|z|)^2+4N^{-1}|z|}+(1-|z|)}\end{aligned}$$

And the equality sign in (2,1) takes place when and only when $F(z)$ is of the form (1.6), where $\varphi_1(z)$ is defined by (1.5).

Now, putting $\xi=\dfrac{\exp\frac{2}{N}F(|z|)-1}{\exp\frac{2}{N}F(|z|)+1}$, we have

$$r\leqq|\xi|\leqq R$$

and

$$F(z)=\frac{N}{2}\log V\quad (V=\frac{1+\xi}{1-\xi}).$$

The domain $r\leqq|\xi|\leqq R$ in ξ-plane is mapped by $V=\frac{1+\xi}{1-\xi}$ to a ring domain in V-plane, the boundary of which are two circles $\boldsymbol{C}$ and $\boldsymbol{K}$. (Fig.1)

Centers C, K and radii ρ_C, ρ_K of the circles $\boldsymbol{C}$ and $\boldsymbol{K}$ are respectively given by

$$V=\frac{1+r^2}{1-r^2},\quad V=\frac{1+R^2}{1-R^2}$$

and

$$\rho_c=\frac{2r}{1-r^2},\qquad \rho_K=\frac{2R}{1-R^2}$$

So that, for $F(z)=\frac{N}{2}\log V$,

$$(2.3)\qquad \begin{aligned}\left|V-\frac{1+r^2}{1-r^2}\right|&\geqq\frac{2r}{1-r^2}\\ \left|V-\frac{1+R^2}{1-R^2}\right|&\leqq\frac{2R}{1-R^2}\end{aligned}$$

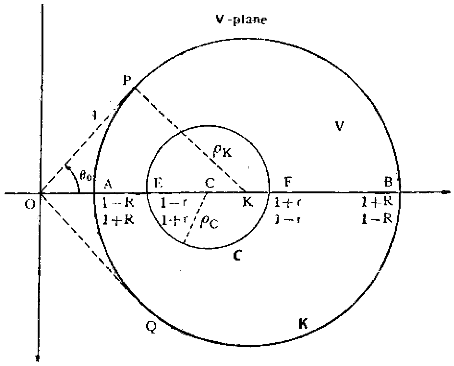

Fig. 1

and, from $|A\hat{V}B|\geqq\pi/2$, $|E\hat{V}F|\leqq\pi/2$ in Fig. 1, we get

$$(2.4)\qquad \left|\arg\frac{V-\dfrac{1+r}{1-r}}{V-\dfrac{1-r}{1+r}}\right|\leqq\pi/2,\qquad \left|\arg\frac{V-\dfrac{1+R}{1-R}}{V-\dfrac{1-R}{1+R}}\right|\geqq\pi/2$$

and equality signs in (2.3) and (2.4) take place when and only when $F(z)$ is defined by (1.6).

If $F(z)$ is of the type (A) and $|R[F(z)]|<M$, the same results (2.3) (2.4) can be attained by using $\varphi(z)$ defined by (1.4) and extremal cases in (2.3) (2.4) hold when and only when $F(z)$ is defined by (1.7).

Hence we have the following results.

Theorem 2.

We put, for any function $F(z)$ of the class $\mathfrak{S}$,

$$F(z)=\frac{N}{2}\log V\quad (|I[F(z)]|<M),\quad F(z)=\frac{N}{2i}\log V\quad (|R[F(z)]|<M).$$

Then we have the properties (2.3) *and* (2.4), *where* $N=\frac{4M}{\pi}$ *and* r, R *are given by* (2.2). *And there exists the function of the class* $\mathfrak{S}$ *for which the equalities in* (2.3) *and* (2.4) *hold true.*

From this theorem and Fig. 1, we obtain

$$(2.5)\qquad \frac{1-R}{1+R}\leqq|V|\leqq\frac{1+R}{1-R}$$

and

$$(2.6)\qquad |\arg V|\leqq\theta_0=\tan^{-1}\frac{2R}{1-R^2}=2\tan^{-1}R$$

for the functions

$$(2.7)\qquad F(z)=\frac{N}{2}\log V=\frac{N}{2}(\log|V|+i\arg V)$$

and

$$(2.8)\qquad F(z)=\frac{N}{2i}\log V=\frac{N}{2}(\arg V-i\log|V|).$$

If the equality takes place in (2.5), we get, by Fig. 1,

$$V=\frac{1-R}{1+R}\quad\text{or}\quad V=\frac{1+R}{1-R}$$

and

$$I[F(z)]=\frac{N}{2}\arg V=0\quad\text{for}\quad(2.7)$$

$$R[F(z)]=\frac{N}{2}\arg V=0\quad\text{for}\quad(2.8)$$

and, as V is on the circle $\boldsymbol{K}$, $F(z)$ is of the type (1.6) or (1.7). Conversely, if $F(z)$ be of the type (1.6) or (1.7), the equality in (2.5) holds for the two points in z-plane which correspond to $V=\frac{1-R}{1+R}$ and $V=\frac{1+R}{1-R}$. Similarly the equality in (2.6) holds when and only when $F(z)$ is of the type (1.6) or (1.7) and z is corresponding point in z-plane to

$$V=\frac{1-R^2}{1+R^2}\pm i\frac{2R}{1+R^2},$$

and, for such points z, $|V|=1$ and

$$R[F(z)]=\frac{N}{2}\log|V|=0\quad\text{for}\quad(2.7)$$

$$I[F(z)]=-\frac{N}{2}\log|V|=0\quad\text{for}\quad(2.8)$$

Hence we have the following

Theorem 3.

Let $F(z)$ be any function of the class $\mathfrak{S}$ and $|I[F(z)]|<M$, then in $|z|<1$,

$$|R[F(z)]|\leqq\frac{N}{2}\log\frac{1+R}{1-R}$$

$$|I[F(z)]| \leqq \frac{N}{2}\tan^{-1}R,$$

where R *is given by* (2.2) *and* $N=\frac{4M}{\pi}$.

If $F(z)$ *be of the class* $\mathfrak{S}$ *and* $|R[F(z)]| < M$, *then the same results hold true by exchanging* $R[F(z)]$ *and* $I[F(z)]$.

The equality can be attained only for the points in z-plane which correspond to

$$F(z)=\pm\frac{N}{2}\log V \quad or \quad F(z)=\pm\frac{N}{2i}\log V,$$

where $V=\frac{1-R}{1+R}$ *or* $V=\frac{1-R^2}{1+R^2}+i\frac{2R}{1+R^2}$, *and* $F(z)$ *isgivnby* (1.6) *or* (1.7).

And the points $F(z)$ *corresponding to such points lie on the real-axis or on the imaginary-axis.*

§ 3.

Let $F(z)$ be any function regular and univalent in $|z|<1$, and

$$|F(z)|<M, \quad F(0)=0, \quad F'(0)=1,$$

then it is already known that the mapped domain D of $|z|<1$ by $W=F(z)$ contains the circle

$$|W|<M(2M-1-2\sqrt{M(M-1)}).$$

And a boundary point of D is on this circle when and only when $F(z)$ is of the form

$$\frac{F(z)}{[1+\frac{\varepsilon}{M}F(z)]^2}=\frac{z}{[1+\varepsilon z]^2}, \quad |\varepsilon|=1.$$

We intend to consider, in this section, the same problem for the function $F(z)$ of the class $\mathfrak{S}$.

.From the above theorem, the circle

$$|W|<N\rho_0 \quad (\rho_0=2N-1-2\sqrt{N(N-1)})$$

is contained in the mapped domain of $|z|<1$ by $W=\varphi(z)$, where $\varphi(z)$ is defined by (1.3), if $|I[F(z)]|<M$.

Putting $\varphi(z)=N\xi$ and $V=\frac{1+\xi}{1-\xi}$, then we have

$$Z=F(z)=\frac{N}{2}\log V=\frac{N}{2}(\log|V|+i\arg V),$$

and, by the transformations $W=N\xi$, $V=\frac{1+\xi}{1-\xi}$, the circle $|W|<N\rho_0$ is mapped to the circle $\boldsymbol{H}$: $|V-a|<\rho$ in V-plane, where $a=\frac{1+\rho_0^2}{1-\rho_0^2}$ and $\rho=\frac{2\rho_0}{1-\rho_0^2}$ are center and radius respectively of the circle $\boldsymbol{H}$. (Fig. 2)

On the boundary of the circle $\boldsymbol{H}$, we have

$$V=a+\rho e^{i\theta}, \quad (0\leqq\theta<2\pi)$$

$$|V|=\sqrt{a^2+\rho^2+2a\rho\cos\theta}, \qquad \arg V=\tan^{-1}\frac{\rho\sin\theta}{a+\rho\cos\theta}.$$

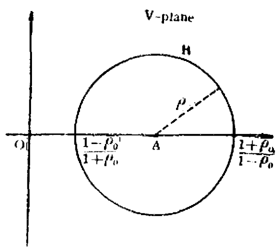

Fig. 2

Hence the circle is mapped to the closed curve $\boldsymbol{C}$;

$$R[Z]=\frac{N}{4}\log(a^2+\rho^2+2a\rho\cos\theta)$$

$$I[Z]=\frac{N}{2}\tan^{-1}\frac{\rho\sin\theta}{a+\rho\cos\theta}$$

in the Z-plane by the function $Z=\frac{N}{2}\log V$, and therefore the inside of the circle $\boldsymbol{H}$ corresponds to the inside of the closed curve $\boldsymbol{C}$.

As the domain in W-plane, to which the circle $|z|<1$ is mapped by $W=\varphi(z)$, corresponds to the mapped domain B in Z-plane of $|z|<1$ by $Z=F(z)$, we get the conclusion that the inside of the curve $\boldsymbol{C}$ lies entirely in the domain B.

In the above discussion, as the boundary of $\boldsymbol{C}$ corresponds to the boundary of the circle $|W| = N\rho_0$, we get, by the theorem cited at the begining of this section, that the curve $\boldsymbol{C}$ has at least a boundary point of the domain B when $F(z)$ is of the type (1.6).

The similar results for the case $|R[F(z)]| < M$ can be attained by the method using in § 2. Thus we have the theorem as follows.

Theorem 4.

Let $F(z)$ be any function of the class $\mathfrak{S}$ and $|I[F(z)]| < M$, then the mapped domain B of $|z| < 1$ by $W = F(z)$ contains the inside of the closed curve $\boldsymbol{C}$;

$$R[W] = \frac{N}{4}\log(a^2+\rho^2+2a\rho\cos\theta)$$

$$I[W] = \frac{N}{2}\tan^{-1}\frac{\rho\sin\theta}{a+\rho\cos\theta}. \qquad (\theta\text{: parameter})$$

And the domain B has at least one of it's boundary points on the boundary of $\boldsymbol{C}$ whan and only when $F(z)$ is of the type (1.6).

If $F(z)$ be of the class $\mathfrak{S}$ and $|R[F(z)]| < M$, the same results hold true by exchanging the curve $\boldsymbol{C}$ to the curve $\boldsymbol{C}'$ which is got through rotating $\boldsymbol{C}$ by the angle $-\pi/2$ about the origin.

§ 4.

We have already known the following theorems for the mapped domain B of $|z| < 1$ by $W = F(z)$ which is regular univalent and normalised in $|z| < 1$.

(i) If W_1 and W_2 are the boundary points of the domain B and lie on the opposite side with respect to the origin on the straight line passing through $W = 0$, then at least one of $|W_1|$ or $|W_2|$ is not less than 1/2.[6]

(ii) If the domain B is convex, then at least one of $|W_1|$ or $|W_2|$ is not less than $\pi/4$.[7]

We add to a similar property for the mapped domain B.

Let $F(z)$ be a function given above, and we assume that

$$(4.1) \qquad |I[e^{-i\alpha}F(z)]| < \pi/4, \qquad (\alpha : \text{real})$$

i, e, the domain B lies inside the stripe region S, the boundary of which is two parallel lines having the distance $\pi/4$ from the origin and with the direction α. Then

$$(4.2) \qquad \Psi(z) = e^{i\alpha}\frac{\exp 2e^{-i\alpha}F(z)-1}{\exp 2e^{-i\alpha}F(z)+1}$$

is regular and univalent in $|z| < 1$ and

$$|\Psi(z)| < 1, \qquad \Psi(0) = 0 \qquad \Psi'(0) = 1.$$

Therefore we have, by the theorem due to Schwarz,

$$(4.3) \qquad \Psi(z) = z$$

$$(4.4) \qquad F(z) = \frac{e^{i\alpha}}{2}\log\frac{1+e^{-i\alpha}z}{1-e^{-i\alpha}z}.$$

So that, if $F(z)$ is not the function of (4.4), (4.1) is impossible and, for $F(z)$ in (4.4), the boundary of the domain B is coincide with the boundary of the stripe region S. Hence there exists a point z_0 ($|z_0| < 1$) for which $|I[e^{-i\alpha}F(z_0)]|$ is not less than $\pi/4$, if the Function $F(z)$ is not of the form (4.4). Being α arbitrary we can state as follows.

Theorem 5.

Let $F(z)$ ($F(0) = 0$, $F'(0) = 1$) be any function regular and univalent in $|z| < 1$.

If $F(z) \frac{1}{2\varepsilon}\log\frac{1+\varepsilon z}{1-\varepsilon z}(|\varepsilon|=1)$, *then there exists a inner point of the mapped domain of* $|z|<1$ *by* $W=F(z)$ *which lies outside or on the boundary of the stripe region made by two parallel lines having the distance* $\pi/4$ *from the origin and with arbitrary direction.*

And if $F(z)\equiv\frac{1}{2\varepsilon}\log\frac{1+\varepsilon z}{1-\varepsilon z}(|\varepsilon|=1)$, *then the above result is also true except one direction of two parallel lines*

§ 5.

Let $F(z)$ be a function of the type (A) and $|I[F(z)]|<M$, then

$$(5.1)\qquad \varphi(z)=N\frac{\exp\frac{2}{N}F(z)-1}{\exp\frac{2}{N}F(z)+1}\quad(N=4M/\pi)$$

is regular in $|z|<1$ and

$$|\varphi(z)|<N,\qquad \varphi(0)=0,\qquad \varphi'(0)=1.$$

Therefore, by the theorem of Dieudonné[8], $\varphi(z)$ is univalent in $|z|<\rho$, where $\rho=N-\sqrt{N^2-1}$, and we have, for the function $\varphi(z)=Nz\frac{1-Nz}{N-z}$, $\varphi'(\rho)=0$.

As the univalency of $F(z)$ follows from that of $\varphi(z)$, $F(z)$ is also univalent in $|z|<\rho$.

We have, for the function defined by

$$F(z)=\frac{N}{2}\log\frac{1+z\frac{1-Nz}{N-z}}{1-z\frac{1-Nz}{N-z}},$$

$$F'(z)=N\frac{1-2Nz+z^2}{(1-z^2)(N-2z+Nz^2)}$$

and $F'(\rho)=0$. So that ρ is the best possible number for univalency.

That the above argument is also true for the function of the type (A) and $|R[F(z)]|<M$ can be proved by the similar manner, taking

$$(5.2)\qquad \varphi(z)=\frac{N}{i}\frac{\exp\frac{2i}{N}F(z)-1}{\exp\frac{2i}{N}F(z)+1}$$

instead of (5.1).

Thus we have the following

Theorem 6.

Let $F(z)$ *be any function which is regular normalised in* $|z|<1$ *and* $|R[F(z)]|<M$ *or* $|I[F(z)]|<M$, *then* $F(z)$ *is univalent in* $|z|<N-\sqrt{N^2-1}$, *where* $N=4M/\pi$. *And the number* $N-\sqrt{N^2-1}$ *cannot be replaced by any greater one.*

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絹の過酸化水素漂白に際して生ずる赤變の原因に就いて

宮岡宇一郎　清水　融

On the cause of redding occured when the silk bleached with hydrogen peroxide.

Uichiro MIYAOKA, Tooru SHIMIZU

The degummed silk is commonly treated with hydrogen peroxide in oder to improve its whiteness. During this treatment the silk often shows pink colour.

We have engaged to study the cause of this phenomenon and confirmed to come from the oxidation of tyrosine as a constituent of silk.

we have also found the optimum conditions to prevent the "redding" with regard to the concentration of hydrogen peroxide, pH of the solution used and the temperature for the bleaching.

This is a part of our work on the investigations to prevent the browning or Yellowing of the silk fibre.

緒　言

一般に精練した羽二重，縮緬等はその白度を高めるため，更に過酸化水素の漂白を行つている。この工程に於いてしばしば赤味を帯びる。その原因に就ては種々説明されて居るが，これを根本的に研究した満足な報告は未だ見られない。この現象の原因としては使用容器や外部からの色素物質の混入も考えられるが，これらは何れも二義的なものであつて，その根本は絹本来の性質に基くものである。よつてその原因を究明するために下記の実験を行つた。

實　驗　方　法

(Ⅰ) 練絹 0.5gr を各種 pH 緩衝液 50c.c. と0.3%過酸化水素 1c.c. からなる溶液に浸し，一定温度，一定時間処理し，布の白度及び残存過酸化水素の量を測定した。漂白には擦合せの冷却管をつけた硬質ガラス製の 150c.c. 入丸底フラスコを用い，之を恒温槽に容れた。恒温槽の温度偏差は ±0.3°C である。

緩衝溶液[1]として，

pH 1 ～2.2	N/5·HCl+N/5 KCl
2.32～3.49	N·HCl+N·CH_3COONa
3.6 ～5.4	M/5 CH_3COOH+M/5 CH_3COONa
5.59～8.04	M/15 Na_2HPO_4+M/15 KH_2PO_4
8.2 ～11.0	M/10 H_3BO_3·HCl混液+M/10 Na_2CO_3

を使用した。

残存過酸化水素量の測定には試料漂白溶液 25c.c. を有栓フラスコにとり，沃度カリ 1gr と硫酸 (D.1.16) 25c.c. を入れ30分放置後，これを N/4 チオ硫酸ソーダで澱粉を指示薬として滴定した。試料絹布は14匁付縮緬を浴比 1:50，0.03 g/L の炭酸ソーダ溶液中に50分，95°C で処理し，しぼ寄せした後，浴比 1:50，1g/L の石鹸液で2時間 95°C で処理し，温湯で水洗，次に浴比 1:50，0.5g/L の石鹸液で 1.5 時間処理した後，60°C 蒸溜水で洗い，0.03g/L の炭酸ソーダで 60°C で洗滌後 40～50°C の蒸溜水で3回，冷蒸溜水で2回洗滌して調製した。絹布の練減量は25%である。布の白度は肉眼で比較した。

(Ⅱ) 絹成分であるチロジンに就て検討した。